

## CHAPTER III WATERSHED CHARACTERISTICS

### A. LAKE MORPHOLOGY

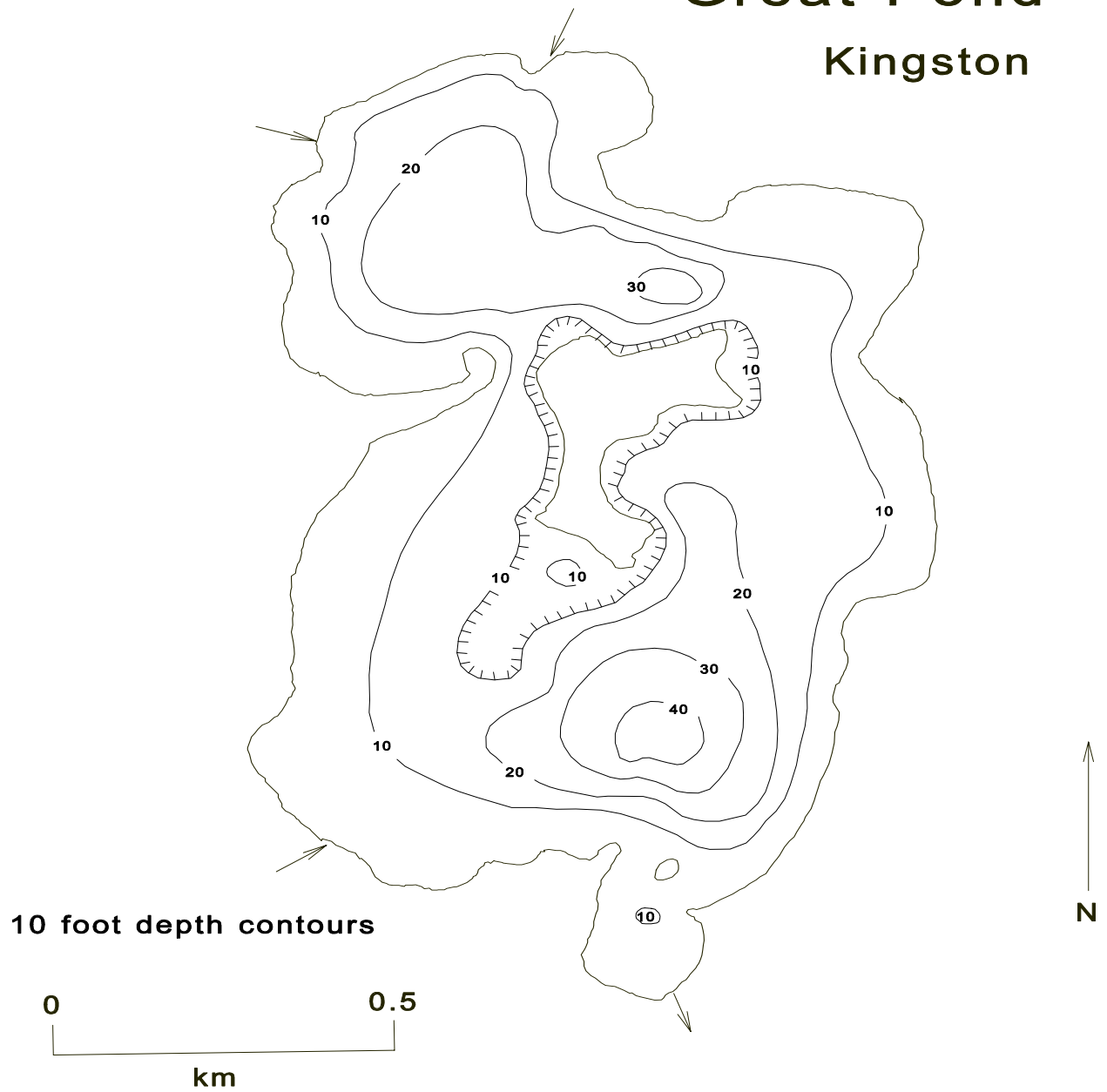
Great Pond is a naturally formed water body with a dam controlled outlet. The surface area is 82.6 hectares with a maximum depth of 14.6m, and a mean depth of 4.5m. Morphological characteristics of the lake and watershed are tabulated in Table III-1.

Figure III-1 is a bathymetric map of the lake, showing a lake with two deep sites in the northern and southern part of the lake separated by an island. There is also a shallow area to the south of the island that supports macrophyte growth despite being several hundred feet from shore.

**Table III-1**

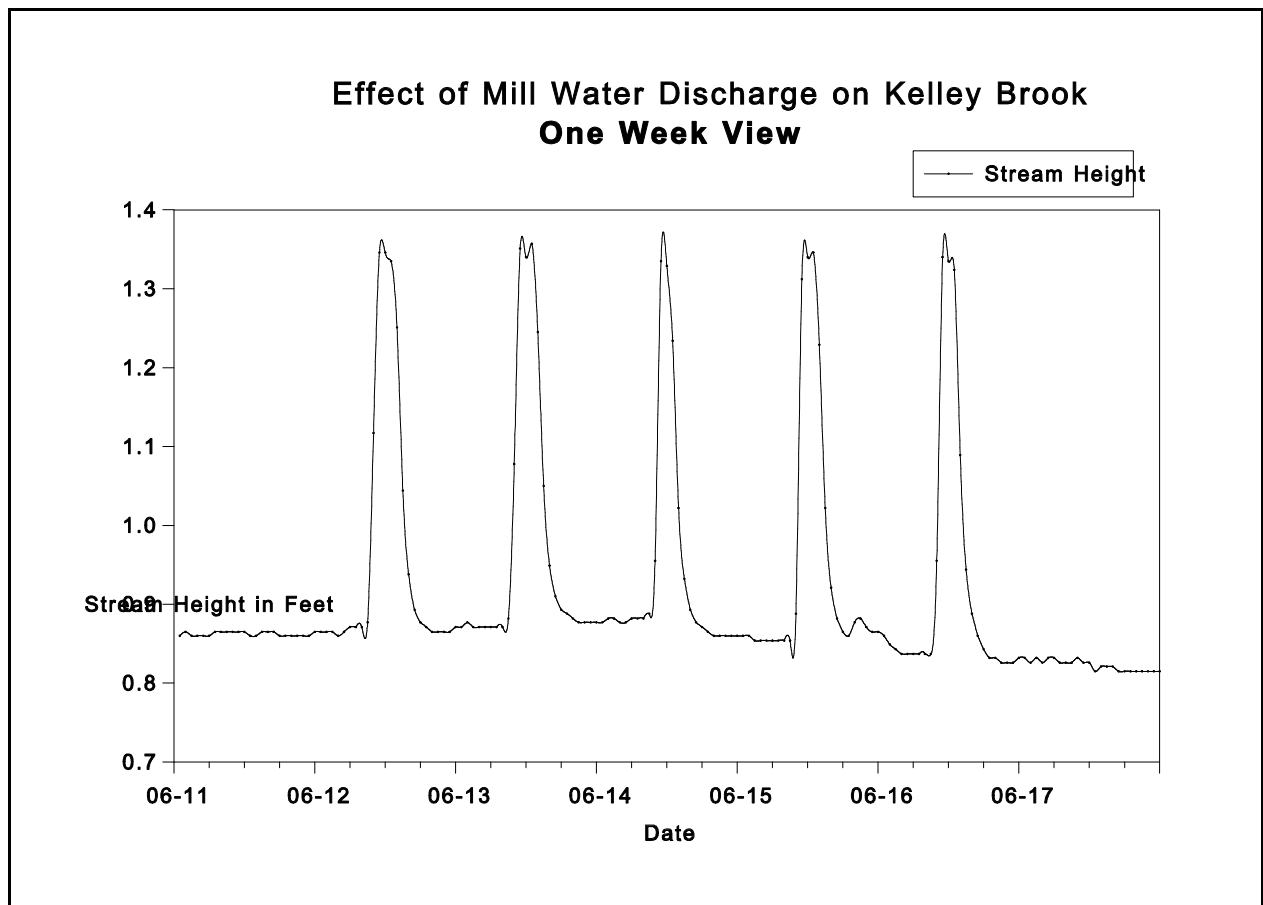
Great Pond Morphological Data			
Lake:	Great Pond	Lake Area (ha):	82.60
Town:	Kingston	Maximum Depth (m):	14.6
County:	Rockingham	Mean Depth (m):	4.5
River Basin:	Merrimack	Volume (m <sup>3</sup> ):	3,700,000
Latitude:	42°55'	Relative Depth:	1.4
Longitude:	71°04'	Shore Configuration:	2.05
Elevation (ft):	117	Areal Water Load (m/yr):	16.76
Shore Length (m):	6600	Flushing Rate (yr <sup>-1</sup> ):	2.6
Watershed Area (ha):	2175.6	P Retention Coeff. R:	.53
% Watershed Poned:	1.3	Lake Type:	Natural

# Great Pond Kingston



## B. GENERAL HYDROLOGY AND TOPOGRAPHY

The Great Pond watershed encompasses an area of approximately 6,432 acres and contains a major lake, three ponds, 936 acres of wetlands, 3964 acres of mixed forest, and three major tributaries. Roughly half (47%) of the watershed lies within the Town of Kingston, New Hampshire, while the other half (53%) lies in the Town of Danville, New Hampshire. The majority of the drainage comes to Great Pond via Long Pond and Kelley Brook whose subwatershed constitutes more than half of the entire Great Pond watershed. Kelley Brook also features an active saw mill that causes large fluctuations in stream flow while the mill is in operation (see Figure III-2).



The watershed is characterized by gently rolling hills covered primarily by forests and wetlands (76%). The northeast corner of the watershed is a prime example of this type of land cover; here forest and wetland complexes are broken up by only a scattering of development and agriculture. It is also here where the Rock Rimmon State Forest lies, named for the 350 foot rocky outcrop that once featured a fire tower, and is the watershed's highest point.

The southeast corner of the watershed is more developed, here development shares the land equally with forests and wetlands. Most of the development is residential. Some agriculture exists, but it is clear that agriculture in the Great Pond watershed is a mere shadow of what it used to be. Most of the farms are in the hands of hobby farmers, with surrounding fields laying dormant or given up to developers. Figure III-3 delineates watershed boundaries and illustrates prominent topographical features within the Great Pond watershed.

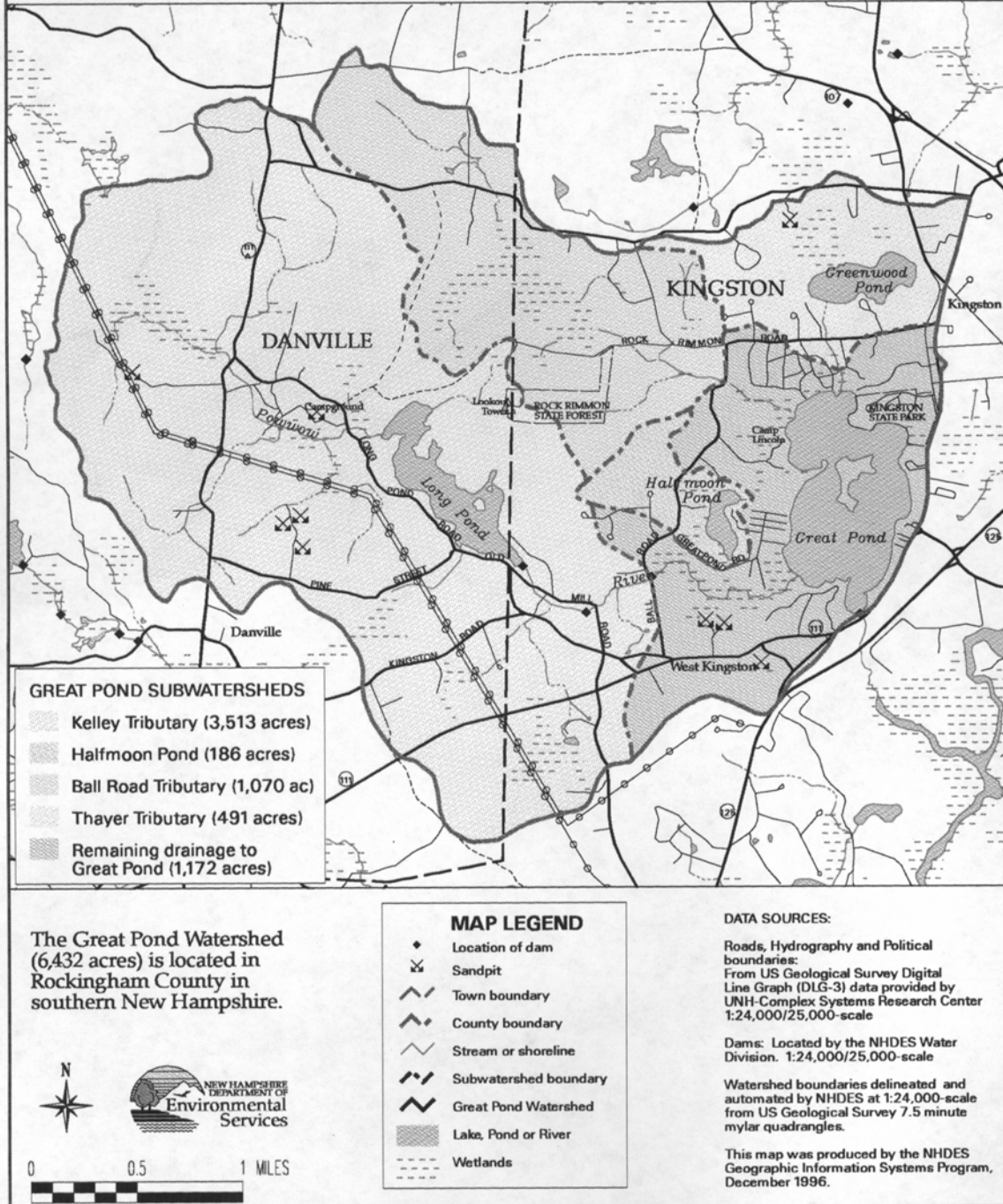
### **C. CLIMATE**

Great Pond is located in the Town of Kingston, which lies in Rockingham County, New Hampshire, approximately 30 miles southeast of Concord, New Hampshire at coordinates 42°55'00" North and 71°04'00" West.

The climate of the region is characterized by moderately warm summers, cold, snowy winters, and ample rainfall. The weather is occasionally influenced by the Atlantic Ocean which is about 25 miles to the east. However, the prevailing winds are from the west, thus the climate is more influenced by air masses moving in from the interior of the continent rather than the air moving landward from the ocean. Daily temperatures can be quite variable because of changing weather patterns that alternately transport warmer air from a southerly direction and colder air from a northerly direction. In winter, the average temperature is 24 degrees fahrenheit and the average daily minimum is 13 degrees fahrenheit. In summer, the average temperature is 67 degrees fahrenheit and the average daily maximum temperature is 80 degrees fahrenheit.

The total annual precipitation for the study area is about 43 inches, including the water equivalent of snow. Generally, snow is present from mid-December to the end of March. Precipitation in this region is acidic.

## GREAT POND WATERSHED - BASE MAP FEATURES



## **D. GEOLOGY**

### **1. Physiography**

Great Pond lies within a region known as New England and Eastern New York Upland. The region is characterized by rolling hills, low mountains and broad valleys. Maximum elevation in the Great Pond watershed is approximately 350 ft. above sea level.

The outlet of Great Pond forms the Powwow River which eventually drains into the Merrimack River in Amesbury Massachusetts. In addition to Great Pond, there are two ponds within the watershed over ten acres: Greenwood Pond, which lies to the north and drains into Great Pond via Thayer Brook, and Long Pond, which lies to the west in the town of Danville and drains into Great Pond via Kelley Brook. Though less than ten acres in size, Halfmoon Pond lies less than a quarter mile to the west, and drains into the wetland that forms the mouth of Kelley Brook. A large wetland complex in the northwestern end of the watershed also drains into Great Pond via the Ball Road tributary.

### **2. Geology**

When considering the geology of an area, it is important to remember that the majority of the earth's crust is undergoing constant recycling. The earth is estimated to be about 4,600 million years old, while the oldest rocks in New Hampshire can be traced back only to around 650 million years, placing them in the late Precambrian period. These rocks are classified as metamorphic, and form the foundation upon which the Great Pond watershed lies.

The rocks within the Great Pond watershed originated approximately 355 million years ago, when most of central and southeastern New Hampshire was under a great inland sea. This sea became the recipient of large amounts of sand and mud, which was being eroded from the region's highlands and carried to the sea via rivers and streams. Hundreds of millions of years of this deposition resulted in a great sheet of sand and mud more than 20,000 feet thick at the bottom of the sea. The land began to rise and the sea receded about 290 million years ago, leaving the land dry and exposing the bulk of this erodite which was the precursor to the sedimentary rock of New Hampshire.

The rocks derived from these sediments became phyllites, micaceous rocks similar to roofing slate, mica schists and quartz-mica schists. These newly formed rocks soon began the process of breaking down, being exposed to erosion by wind and rain activity. Geologic forces exerted on the eastern shore of the precontinent caused the land to undergo severe buckling and folding, creating weak spots in the crust. Magma rose up from the earth's core and invaded the newly formed folds and fractures. These occurrences formed pegmatite dikes with embedded quartz, feldspar and mica which are common throughout New Hampshire.

Pressure and heat caused the sedimentary rocks to metamorphose into several different rock types. These can be broken down into different categories, depending on the foliation type, or banding of minerals within the rock, and grain type. Both of these characteristics depend on the original type of sedimentary material from which the rock was derived. Some of the prominent metamorphic rocks in New Hampshire are quartzites, schists, muscovite, garnet, chlorite, biotite, staurolite, and silimanite.

The Great Pond watershed is situated in the region that is known as the Merrimack Formation group of bedrock. This group is made up of the Kittery, Eliot and Burwick Formations, which are believed to have originated in the Silurian/Ordovician periods. The Great Pond watershed consist of both Eliot and Burwick formations, with the Burwick formation overlying the Eliot Formation.

The present day landscape of the Great Pond watershed was a result of the glacial activity during the Pleistocene epoch, which began about 1.6 million years ago. During that time the continental ice sheet advanced and retreated across the region as many as four times. Starting in Labrador and northern Canada, ice spread out in all directions forming a massive glacier. It reached southern New Hampshire from the northwest, which is evident from the northwest trending striations on rock surfaces and by the shape and direction of hills carved or deposited by the ice sheet.

The Great Pond area was covered by continental glaciers during several periods from approximately one million years ago to about 20,000 years ago, when the ice sheet covering New Hampshire began to melt and its southern margin retreated northward. The last remnants of the glacier covering New Hampshire disappeared about 14,000 years ago.

As the glaciers melted and receded, sediments held within the ice were carried away by

the meltwaters. These sediments were differentially deposited in areas where the meltwater's velocity was slow enough for the particles to settle. "Deposits of sediment formed distinct layers of differing grain sizes that were sorted according to the fluvial environment at the time; these deposits are termed stratified drift" (Toppin, 1987). A large percentage of the Great Pond watershed consists of ice-contact stratified drift deposits. Ice-contact deposits consist primarily of sand and gravel because meltwater velocity in and around the melting ice was too fast for silts and clays to be deposited. The porosity of ice-contact deposits are very high and are the primary cause of Great Pond's unique hydrologic nature.

## **E. SOILS**

Septic systems typically consist of a septic tank connected to a leach field. The septic tank provides primary treatment by trapping solid organic waste. The liquid wastewater exits into the leach field where it is filtered and drained into the soil. The soil filters this partially treated sewage which eventually drains into the groundwater table or into rivers and lakes that may be nearby.

Septic systems effectively remove organic matter, bacteria and nutrients if properly designed and maintained. They only work, however, if the proper site conditions exist. Soils play a key role in treating wastewater; however, tightly bound or poorly drained soil types such as clays are not effective filters. Gravel is also a poor filter because wastewater drains too rapidly to receive treatment.

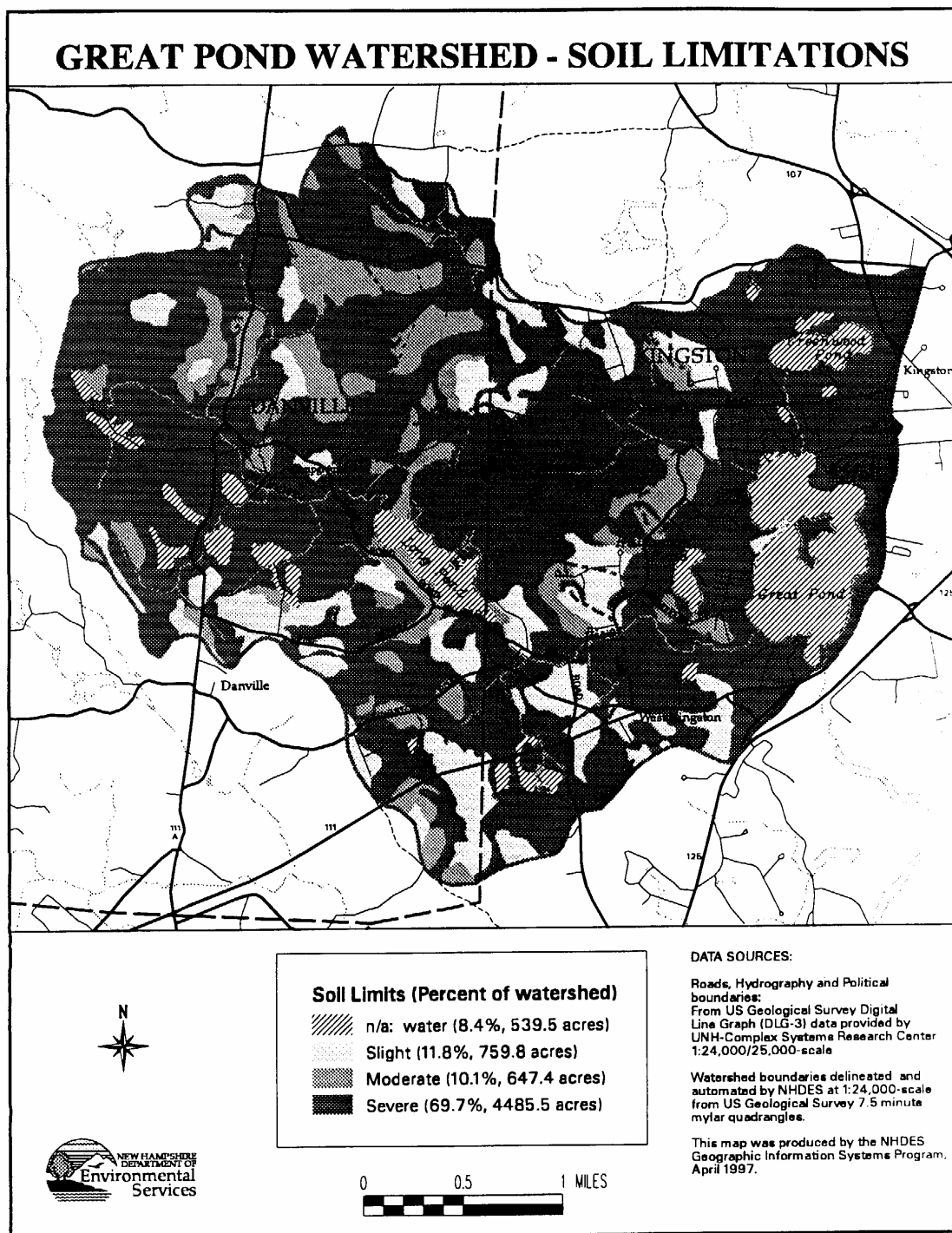
Figures III-4 and III-5 depict soil limitations for individual septic system design criteria in the Great Pond watershed and in the area adjacent to the lake respectively. These soil limitation maps help local planners zone their towns for future growth. Knowing what areas are best for septic systems minimizes the potential for water pollution problems in the future.

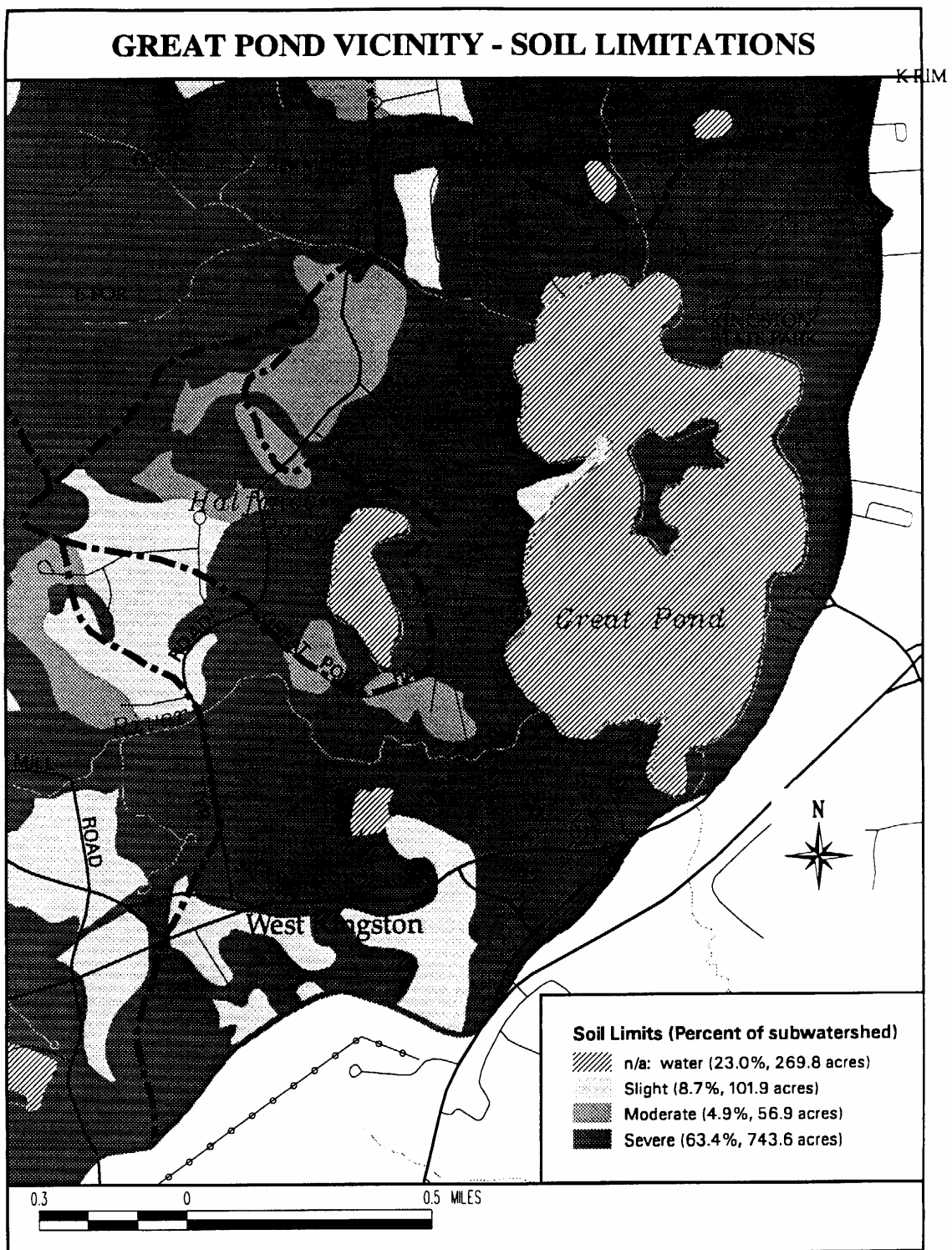
Table III-2 itemizes the various soil limitation areas by total acreage and percentage of the watershed for the entire watershed and the vicinity of the lake respectively. Approximately 70% of the soils in the Great Pond watershed have severe limitations for septic systems. Soils that are a poor filter or limited by depth to bedrock account for one third of the watershed. Soils limited by wetness or ponding account for another 28%. Only 22% of the entire watershed have a septic



system limitation rating of slight or moderate.

Within the vicinity of Great Pond, which consists of the 1200 acre area directly adjacent to the lake, the dominant limitation for septic systems is poor filtration (41%). As with the rest of the watershed, ponding or wetness is a common severe limitation within the vicinity of Great Pond, accounting for 20% of the total area. As Figure III-5 shows, all of the land that abuts the lake, except for a small uninhabited peninsula near Camp Lincoln, is severely limited for septic systems.





**Table III-2**

<b>Soil Limitations For Septic Systems - Great Pond Watershed</b>				
	<b>Entire Watershed</b>		<b>Vicinity</b>	
<b>Limitation Description</b>	<b>Acres</b>	<b>Percent</b>	<b>Acres</b>	<b>Percent</b>
Slight	759.8	12.0	101.9	8.7
Moderate - Slope	647.4	10.2	56.9	4.9
Severe - Depth to Rock	134.2	2.1	-	-
Severe - Depth to Rock - Mod. Slope	717.0	11.3	19.1	1.6
Severe - Depth to Rock - Slope	50.1	0.8	-	-
Severe - Percs Slowly	14.2	0.2	0.7	0.1
Severe - Percs Slowly - Slope	2.7	> 0.1	-	-
Severe - Percs Slowly - Slope - Wetness	7.3	0.1	-	-
Severe - Percs Slowly - Wetness	184.5	2.9	-	-
Severe - Ponding - Percs Slowly	43.6	0.7	-	-
Severe - Ponding - Poor Filter	171.6	2.7	8.1	0.7
Severe - Poor Filter	1217.5	19.3	480.3	41.0
Severe - Poor Filter - Slope	24.4	0.4	-	-
Severe - Slope	88.7	1.4	-	-
Severe - Slope - Depth to Rock	255.1	4.0	4.2	0.4
Severe - Subsides - Ponding	668.1	10.6	81.2	6.9
Severe - Subsides - Ponding - Percs Slowly	148.0	2.3	62.2	5.3
Severe - Wetness - Percs Slowly	490.1	7.8	52.0	4.4
Severe - Wetness - Poor Filter	268.4	4.2	35.8	3.1
Water	539.5	8.5	269.8	23.0

**Key:**    **Variable-**    Limitations need to be determined; these areas consist of land covered by streets, parking lots, and

buildings intermingled with soil inclusions that make up less than 45% of the map unit.

**Moderate-** Soil properties or site features are not favorable for the indicated use, special planning design, or maintenance is needed to overcome or minimize limitation.

**Severe-** Soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

## **F. LAND COVER AND LAND USE REGULATION, GENERAL OVERVIEW**

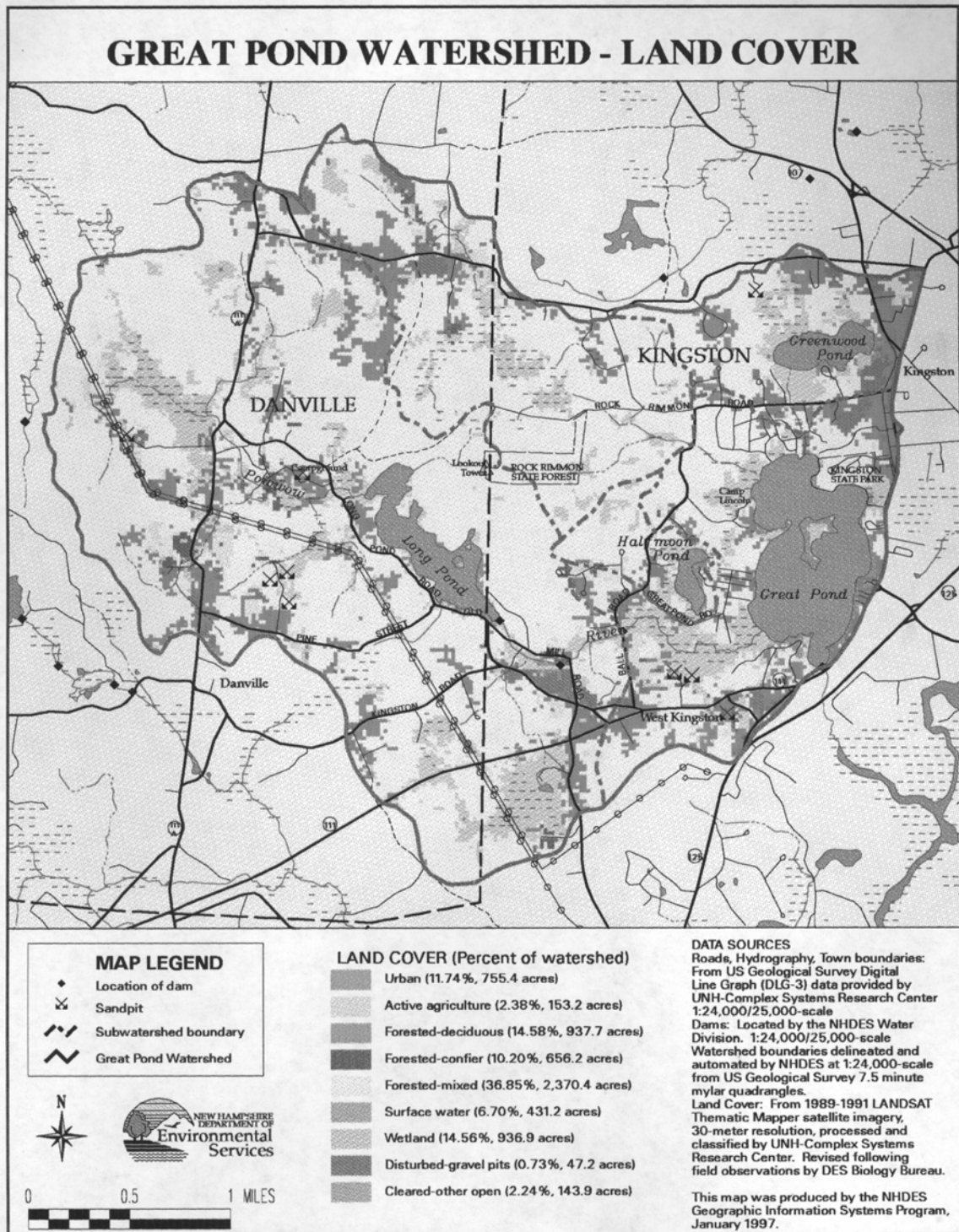
The water quality of a lake or pond is influenced, in part, by the type of human and natural activities that occur within the confines of a watershed. Much of the rainwater, snow melt-water and groundwater found within the watershed will eventually end up in the lake or pond. The downward migration of the surface and groundwater can carry pollutants found in the watershed, including nutrients such as phosphorus and nitrogen which can cause algae blooms and accelerated eutrophication, to the lake.

Poor farming practices, the buildup of large urban areas, and the removal of native vegetation are the most common human activities that impair lake quality and accelerate cultural eutrophication. Human intrusions into a watershed will accelerate the degradation of water quality much faster than natural processes.

Data pertaining to existing land use in the Great Pond watershed was derived from a land use map developed from LANDSAT Thematic Mapper (TM) imagery, using a 30 meter resolution. The image processing was performed by Complex Systems Research Center, UNH, 1993. The final maps were prepared by NHDES GIS program. Inaccuracies in the original map were corrected with field investigations. Figure III-6 details an estimated breakdown of the current land use in the Great Pond watershed.

At first glance, it appears that the watershed is underdeveloped, since the urban/residential areas only account for 12.0% of the total watershed and almost 85% of the watershed is occupied by forests, wetlands, and open water. A closer look reveals that the area around the lake is more heavily developed than the rest of the watershed. With around 100 first

tier homes and two housing developments arounds the lake's edge, the watershed as a whole is not indicative of the land adjacent to Great Pond. Great Pond Park, one of those housing developments, is very densely packed with about 120 year round and seasonal homes in an area considerably less than 100 acres. This development presents two problems. The first, which was discussed in the septic limitations section, is that most of the residences around the lake are located in the areas with soils delineated as severely limited either by poor filtration, or shallow depth to bedrock.



The second problem, one that is most acute in the development Great Pond Park,

concerns the designed use versus the actual use of the homes in the area. Many of these homes were built in the early part of this century when there was no state code for septic design. Also, most of these homes were originally used as summer cottages. But as time passed and real estate costs soared, many of these cottages were converted to year round residences. It is doubtful that all of the septic systems were modified to accommodate the increased pressure incurred from year round use. This pressure may be a significant source of nutrient inputs into the lake.

Active agriculture, which occupies 2.4% of the total watershed area, is another land use type that has been found to be a source of nutrients in many watersheds. Most nutrient loading mechanisms from agriculture have been attributed to poor management practices such as over fertilization and field erosion. Due to its limited scope and mitigating factors however, agriculture in the Great Pond watershed has been ruled out as a significant source of nutrients. All but two farms in the watershed are “hobby” farms. Hobby farms are generally small and keep only one type of livestock (i.e. horses). While hobby farms may be a source of nutrients in the watershed, their small size tends to limit their impact. Two larger farms exist in the watershed, one in Danville at the northern fringe of the watershed, and one in Kingston near Kelley Brook.

All runoff and surface water near the farms must pass through a large wetland complex before reaching the pond. Since the flow through this wetland is usually zero, with the exception of spring runoff, it is likely that any nutrients from agricultural activities are utilized for wetland plant growth.

## **G. WETLANDS**

Wetlands are ground features that are periodically or permanently inundated or saturated by surface or groundwater and support vegetation adapted for life in saturated soil. This definition includes swamps, marshes, bogs and similar areas. Wetlands provide fish and wildlife habitat, food chain production, nesting, spawning, rearing and resting sites for aquatic and land species, protection of shorelines from wave action and erosion, storage areas for storm and flood waters, natural recharge areas where ground and surface water are interconnected, and natural water filtration and purification functions.



As Figure III-7 indicates, wetland areas are present throughout the entire Great Pond watershed. Wetland complexes are found within each of the three major in flowing tributary sub-watersheds and account for approximately 15% of the entire watershed. Each of the three major tributaries filter through a wetland before entering Great Pond. The largest wetland adjacent to Great Pond is at the mouth of its largest tributary Kelley Brook. This wetland serves to purify the water from two nutrient rich eutrophic ponds as well as filter sawdust entering the brook from the saw mill. Wetlands also provide large storage capacity for spring runoff and storm events within the watershed. Much of the hydrology within the watershed is influenced by the presence of wetland areas.

